Results by Chemical Group

Metals

Lead

CAS No. 7439-92-1

General Information

Elemental lead is a malleable, dense, blue-gray metal. It can be combined to form inorganic and organic molecules. Lead is a naturally occurring element found in soils and rocks. It has a variety of uses in manufacturing ammunition, solders, metal alloys, ceramic glazes, antique molded or casted ornaments, storage batteries, and shielding from radiation sources. In the past, lead was added to paints and gasoline, and it has been used in plumbing for centuries. Small amounts of lead also may be produced from the burning of fossil fuels.

Since the elimination of leaded gasoline in the United States, general lead exposures for adults have resulted from occupational and recreational sources. For children, the major sources of exposure are from deteriorated

Table 2. Lead

Geometric mean and selected percentiles of blood concentrations (in µg/dL) for the U.S. population aged 1 year and older, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 1 and older	1.66 (1.58-1.73)	.800 (.700-.800)	1.00 (1.00-1.10)	1.60 (1.50-1.60)	2.40 (2.30-2.60)	3.80 (3.50-4.00)	4.90 (4.50-5.50)	7970
Age group								
1-5 years	2.23 (1.99-2.49)	1.00 (.800-1.10)	1.40 (1.10-1.50)	2.20 (1.90-2.50)	3.30 (2.80-3.90)	4.80 (4.00-6.60)	7.00 (5.20-9.90)	723
6-11 years	1.51 (1.35-1.69)	.700 (.600-.900)	.900 (.800-1.10)	1.30 (1.20-1.60)	2.00 (1.70-2.40)	3.30 (2.60-3.90)	4.50 (3.30-6.30)	905
12-19 years	1.10 (1.03-1.18)	.400 (.400-.500)	.800 (.700-.800)	1.00 (1.00-1.10)	1.40 (1.30-1.60)	2.30 (2.10-2.40)	2.80 (2.50-3.00)	2135
20 years and older	1.75 (1.67-1.83)	.700 (.700-.800)	1.00 (1.00-1.10)	1.70 (1.60-1.70)	2.50 (2.40-2.70)	3.90 (3.60-4.10)	5.20 (4.70-5.70)	4207
Gender								
Males	2.01 (1.92-2.10)	.800 (.800-.900)	1.30 (1.20-1.30)	1.80 (1.80-1.90)	2.90 (2.70-3.00)	4.40 (4.00-4.80)	6.00 (5.40-6.50)	3913
Females	1.37 (1.30-1.45)	.600 (.500-.600)	.800 (.800-.900)	1.30 (1.20-1.30)	1.90 (1.80-2.10)	3.00 (2.80-3.30)	4.00 (3.60-4.40)	4057
Race/ethnicity								
Mexican Americans	1.83 (1.71-1.95)	.800 (.700-.800)	1.20 (1.10-1.20)	1.80 (1.60-1.90)	2.70 (2.50-3.00)	4.20 (3.80-4.60)	5.80 (5.10-6.60)	2743
Non-Hispanic blacks	1.87 (1.73-2.02)	.700 (.700-.800)	1.10 (1.00-1.30)	1.70 (1.60-1.90)	2.80 (2.50-2.90)	4.20 (3.90-4.70)	5.70 (5.00-6.30)	1842
Non-Hispanic whites	1.62 (1.53-1.71)	.600 (.600-.700)	1.00 (1.00-1.10)	1.60 (1.40-1.60)	2.40 (2.20-2.50)	3.60 (3.30-3.90)	5.00 (4.30-5.90)	2715

lead-based paint and the resulting dust and soil contamination. Other sources of exposure, such as the use of lead solder in canned foods and in leaded water pipes, have also been eliminated. However, uncommon sources of exposure still exist, including unglazed low-temperature-fired ceramic pottery, pewter drinking vessels, plumbing systems with lead-soldered joints, old paint removal, indoor firing ranges, nearby mining and smelting operations.

Increasing amounts of lead in the body, as benchmarked by blood lead levels (BLLs), can cause impaired neurobehavioral development in children, increased blood pressure, kidney injury, and anemia (CDC, 2002). Neurophysiologic decrements can occur in adults as a result of workplace exposure to lead (Araki et al., 2000). At extremely high levels, lead will produce severe central nervous system injury and paralysis. The potential adverse effects of lead on reproduction are areas of ongoing research and may include miscarriage in women with high BLLs and problems with sperm formation in men with high BLLs (Borja-Aburto et al., 1999). The International Agency for Research on Cancer (IARC) has determined on the basis of animal studies that lead is a probable human carcinogen, but more study is needed on the relation of lead exposure to cancer in people (Jemal et al., 2002). Information about external exposure (environmental levels) and health effects is

Table 3. Lead

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 years and older, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6 and older	.758 (.711-.808)	.200 (.100-.200)	.500 (.400-.500)	.800 (.700-.800)	1.30 (1.30-1.40)	2.10 (1.90-2.30)	2.90 (2.50-3.20)	2465
Age group								
6-11 years	1.07 (.952-1.20)	.500 (.400-.600)	.700 (.500-.800)	1.00 (.900-1.20)	1.50 (1.30-1.70)	2.40 (1.80-3.00)	3.40 (2.40-5.10)	340
12-19 years	.656 (.585-.735)	.100 (.100-.200)	.300 (.300-.400)	.600 (.600-.700)	1.10 (.900-1.20)	1.70 (1.40-2.00)	2.20 (1.90-2.50)	719
20 years and older	.743 (.689-.801)	.200 (.100-.200)	.400 (.300-.400)	.700 (.700-.800)	1.40 (1.20-1.50)	2.10 (1.90-2.30)	2.90 (2.50-3.20)	1406
Gender								
Males	.920 (.848-.998)	.200 (.200-.300)	.500 (.500-.600)	.900 (.800-.900)	1.60 (1.40-1.70)	2.40 (2.20-2.90)	3.40 (2.90-3.90)	1227
Females	.632 (.577-.692)	.200 (<LOD-.200)	.300 (.300-.400)	.600 (.600-.700)	1.20 (1.10-1.30)	1.90 (1.60-2.10)	2.40 (2.10-2.80)	1238
Race/ethnicity								
Mexican Americans	1.02 (.916-1.13)	.200 (.200-.300)	.600 (.400-.600)	1.00 (.900-1.20)	1.70 (1.50-2.00)	2.80 (2.30-3.40)	4.10 (3.10-6.20)	884
Non-Hispanic blacks	1.11 (.983-1.25)	.300 (.300-.400)	.700 (.600-.800)	1.10 (1.00-1.20)	1.90 (1.50-2.10)	2.90 (2.40-3.50)	4.20 (3.20-5.70)	568
Non-Hispanic whites	.686 (.632-.745)	.100 (<LOD-.200)	.300 (.300-.400)	.700 (.600-.700)	1.30 (1.10-1.40)	1.90 (1.70-2.20)	2.60 (2.30-3.10)	822

< LOD means less than the limit of detection, which is 0.07 µg/L.

available from the EPA IRIS Web site at http://www.epa.gov/iris and from ATSDR at http://www.atsdr.cdc.gov/toxprofiles.

Interpreting Blood and Urine Lead Levels Reported in the Tables

In this NHANES 1999-2000 sample, BLLs were measured in all participants aged 1 year and older, and urine lead levels were measured in a sample of people aged 6 years and older. Blood lead measurement is the preferred method of evaluating lead exposure and its health effects in people. BLLs are contributed to by both recent intake and an equilibration with stored lead in other tissues. Urinary lead measurements tend to reflect mostly recent exposure and are therefore more variable than blood lead for a given individual. Urinary levels of lead above 20 µg/L should be evaluated by blood lead analysis, if such analyses have not already been conducted.

The U.S. Department of Labor, Occupational Health and Safety Administration (OSHA), requires monitoring of blood lead and reduction of exposure to lead when worker BLLs are higher than 40 µg/dL of whole blood [CFR 1910.1025(j)(2)(i)]. The American Conference of Governmental Industrial Hygienists recommends that BLLs in workers not exceed 30 µg/dL. The Deutsche Forschungsgemeinschaft provides a Biological Tolerance

Table 4. Lead (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in µg/gram of creatinine) for the U.S. population aged 6 years and older, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6 and older	.714 (.671-.759)	.294 (.259-.313)	.444 (.412-.476)	.699 (.655-.745)	1.11 (1.03-1.19)	1.70 (1.55-1.91)	2.37 (2.15-2.86)	2465
Age group								
6-11 years	1.17 (.967-1.42)	.533 (.450-.625)	.746 (.639-.870)	1.06 (.899-1.22)	1.55 (1.25-1.90)	2.71 (1.63-4.71)	4.66 (2.03-18.0)	340
12-19 years	.494 (.457-.535)	.216 (.190-.267)	.328 (.296-.354)	.469 (.415-.494)	.702 (.632-.833)	1.10 (.968-1.33)	1.65 (1.21-2.78)	719
20 years and older	.711 (.665-.760)	.294 (.256-.333)	.452 (.419-.489)	.709 (.652-.750)	1.10 (1.02-1.19)	1.69 (1.50-1.91)	2.31 (2.00-2.74)	1406
Gender								
Males	.718 (.669-.771)	.302 (.258-.343)	.446 (.408-.489)	.693 (.639-.745)	1.10 (.997-1.22)	1.68 (1.50-2.00)	2.43 (2.04-3.33)	1227
Females	.710 (.658-.767)	.290 (.246-.320)	.442 (.392-.481)	.701 (.655-.762)	1.11 (1.04-1.20)	1.74 (1.50-2.02)	2.38 (2.02-2.88)	1238
Race/ethnicity								
Mexican Americans	.939 (.868-1.02)	.367 (.333-.446)	.593 (.516-.667)	.882 (.800-1.02)	1.43 (1.33-1.58)	2.38 (2.05-2.83)	3.31 (2.78-4.18)	884
Non-Hispanic blacks	.720 (.643-.807)	.290 (.258-.351)	.455 (.392-.491)	.667 (.579-.757)	1.11 (.973-1.20)	1.98 (1.52-2.52)	2.83 (2.25-3.70)	568
Non-Hispanic whites	.687 (.630-.749)	.289 (.245-.317)	.423 (.387-.461)	.673 (.619-.732)	1.07 (.987-1.15)	1.66 (1.48-1.86)	2.31 (1.89-2.88)	822

Level (BAT) of 40 µg/dL for workers. The World Health Organization (WHO) level of concern is 20 µg/dL. CDC recommends that children's levels not exceed 10 µg/dL.

Data from NHANES III, phase 2 (1991-1994) showed that 4.4% of children aged 1-5 years had BLLs greater than or equal to 10 µg/dL, and the geometric mean BLL for children 1-5 years old was 2.7 µg/dL (Pirkle et al., 1998). For the current NHANES 1999-2000 sample, 2.2% of children aged 1-5 years had BLLs greater than or equal to 10 µg/dL, with a geometric mean BLL of 2.23 µg/dL. Higher prevalences of elevated BLLs in U.S. children occur in urban settings, lower socioeconomic groups, immigrants, and refugees (Geltman et al., 2001). Children with BLLs greater than or equal to 10 µg/dL are at increased risk for neurocognitive decrements. Pronounced health effects from lead exposure, namely anemia, kidney injury, nerve injury, and overt brain dysfunction, occur at higher levels. In places where leaded gasoline is still used, such as Bangladesh, BLLs are similar to those in the United States before the removal of lead from gasoline (e.g., a mean BLL of 15.0 µg/dL and 87.4% with levels in excess of 10 µg/dL [Kaiser et al., 2001]).

Geometric mean BLLs of the demographic groups were compared after adjustment for the covariates of race/ethnicity, age, gender, and log serum cotinine. Adjusted geometric mean BLLs were higher in the 1-5-year-old group than the 6-11-year-old group, and both these age groups had higher levels than did the 12-19-year-old group. BLLs in the group aged 20 years and older were higher than those of the 12-19-year-old group but lower than in the group aged 1-5 years. BLLs for males were higher than those for females. Mexican Americans and non-Hispanic blacks had higher levels than did non-Hispanic whites. Similar demographic differences were observed for urine lead levels. It is unknown whether differences between ages or races/ethnicities represent differences in exposure, body-size relationships, or metabolism. For instance, to account for the decreasing BLLs observed with increasing childhood ages, several explanations are possible, including decreasing exposure, dilution of lead by growth of body mass, or changing equilibria with bone turnover. Among adults, BLLs increase slowly with age.